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AUTHOR Pucci, Alex L; Reichel, George F.
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ABSTRACT

The general purpose of the occupational analysis is to provide workable, basic information dealing with the many and varied duties performed in the welding occupation, It includes the basic manipulative skills and technical information in the following four areas: oxy/acetylene, electric arc, tungsten inert-gas arc, and metallic inert-arc welding. The document opens with a brief introduction followed by a job description. The bulk of the document is presented in table form. The four areas are broken down into a number of tasks and for each task a two-page table is presented, showing on the first page: tools, equipment, materials, objects acted upon; performance knowledge (related also to decisions, cues and errors); safety--hazard; and on the second page: science; math--number systems; and communications (performance modes, examples, and skills and concepts). Also included in the document are a brief note on abbreviation of welding terms, and 2 sections on safety (eye protection and general safety practices). (BP)

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Occupational Analysis

CE004204

WELDING

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Instructional Materials Laboratory
Trade and Industrial Education
The Ohio State University

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AN ANALYSIS OF THE WELDING OCCUPATION

Developed By

Alex L. Pucci
Vocational Welding Instructor
Normandy High School
Parma, Ohio

George F. Reichel
Vocational Welding Instructor
Max S. Hayes Vocational High School
Cleveland, Ohio

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Coordinator: William L. Ashley

The Instructional Materials Laboratory
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FOREWORD

The occupational analysis project was conducted by The Instructional Materials Laboratory, Trade and Industrial Education, The Ohio State University in conjunction with the State Department of Education, Division of Vocational Education pursuant to a grant from the U.S. Office of Education.

The Occupational Analysis project was proposed and conducted to train vocational educators in the techniques of making a comprehensive occupational analysis. Instructors were selected from Agriculture, Business, Distributive, Home Economics and Trade and Industrial Education to gain experience in developing analysis documents for sixty-one different occupations. Representatives from Business, Industry, Medicine, and Education were involved with the vocational instructors in conducting the analysis process.

The project was conducted in three phases. Phase one involved the planning and development of the project strategies. The analysis process was based on sound principles of learning and behavior. Phase two was the identification, selection and orientation of all participants. The training and workshop sessions constituted the third phase. Two-week workshops were held during which teams of vocational instructors conducted an analysis of the occupations in which they had employment experience. The instructors were assisted by both occupational consultants and subject matter specialists.

The project resulted in producing one hundred two trained vocational instructors capable of conducting and assisting in a comprehensive analysis of various occupations. Occupational analysis data were generated for sixty-one occupations. The analysis included a statement of the various tasks performed in each occupation. For each task the following items were identified: tools and equipment; procedural knowledge; safety knowledge; concepts and skills and mathematics, science and communication needed for successful performance in the occupation. The analysis data provided a basis for generating instructional materials, course outlines, student performance objectives, criterion measures, as well as identifying specific supporting skills and knowledge in the academic subject areas.

PREFACE

The information compiled in this document is an analysis of the required skills used in the performance of duties and tasks by the average welder. It includes the basic manipulative skills and technical information in the following four areas: oxy/acetylene, electric arc, tungsten inert-gas arc, and metallic inert-gas arc welding.

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The Ohio State University
Columbus, Ohio

Jodi Beittel, Communications
Columbus, Ohio

Diana L. Buckeye, Mathematics
University of Michigan
Avon Lake, Ohio

Rick Fien, Chemistry
The Ohio State University
Beechwood, Ohio

N. S. Gidwani, Chemistry
Columbus Technical Institute
Columbus, Ohio

Bruce A. Hull, Biology
The Ohio State University
Columbus, Ohio

Donald L. Hyatt, Physics
Worthington High School
Worthington, Ohio

Glenn Mann, Communications
Columbus, Ohio

Jerry McDonald, Physical Sciences
Columbus Technical Institute
Reynoldsburg, Ohio

Colleen Osinski, Psychology
Columbus Technical Institute
Columbus, Ohio

David Porteous, Communications
University of Connecticut
Colchester, Connecticut

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Columbus Technical Institute
Columbus, Ohio

Jim VanArsdall, Mathematics
Worthington High School
Worthington, Ohio

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The Ohio State University
Caldwell, Ohio

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Mindy Fausnaugh	Typist
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Carol Hicks	Typist
Sue Holsinger	Typist
Barbara Hughes	Typist
Carol Marvin	Typist
Kathy Roediger	Typist

JOB DESCRIPTION

A welder selects equipment, plans layout and welding procedure while applying knowledge of basic measurement skills and concepts, and the welding characteristics and physical properties of metals; sets up equipment and welds parts using arc or gas welding equipment; repairs products by dismantling, straightening, reshaping, and re-assembling them using cutting torch, straightening equipment and proper hand tools.

A welder also secures parts in position for welding by clamping, tack welding, or bolting; fits and welds components which have been fabricated, cast, or forged to assemble structural forms according to blueprings; performs welding operations in the flat, horizontal, vertical and overhead positions, utilizing all types of joint design.

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DUTY I. OXY/ACETYLENE WELDING

A. Set up and test equipment
B. Oxy/acetyl weld mild steel
C. Oxy/acetyl weld pipe
D. Oxy/acetyl weld cast-iron
E. Braze mild steel
F. Braze cast-iron
G. Silver Braze stainless steel
H. Silver braze coper alloys
I. Cut using oxy/acetylene
J. Form and bend
K. Hardface
L. Soft solder

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(TASK STATEMENT) **I-A SET UP AND TEST OXY-ACETYLENE WELDING EQUIPMENT**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxygen and Acetylene Supply Oxygen Regulator Acetylene Regulator Oxygen hose with fittings Acetylene hose with fittings Oxyacetylene Torch Oxyacetylene Torch Tips Leak testing fluids S. T. as required	Attach Oxygen Regulator to Oxygen supply Attach Acetylene Regulator to Acetylene supply Attach Oxygen and Acetylene hoses to respective supply Attach torch Test according to safety procedure	Refer to Index under Safe Practice: X—Safety Precautions for Hand Tools—[Items 1 thru 10] XIX—Oxy-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Attach Oxygen Regulator to Oxygen supply Attach Acetylene Regulator to Acetylene supply Attach hoses to respective supplies Attach torch to respective supplies Appraise results by visual inspection	Type of gas-pressure required Standard colors and fittings Job requirement Job requirement Condition of fittings	Explosive possibilities Explosive possibilities Explosive possibilities Explosive possibilities Damaged fittings-leaks

(TASK STATEMENT) I-A SET UP AND TEST OXY-ACETYLENE WELDING EQUIPMENT

SCIENCE

Fluids under pressure
[Instability of gases under pressure]
[Exceed maximum pressures of equipment]
Relationship of forces to distortion in an elastic body.
[Distort or break brass fittings]

MATH – NUMBER SYSTEMS

Set of Real Numbers—[Positive rationals]
Basic Measurement Skills and Concepts—Instruments
[Read gauge-pounds per square inch, cubic feet per hour]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesturing, Usage
Reading	Read and interpret pressures on both guages Read and follow written instruction for set-up	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Perform operation; appraise finished work	Visual analysis, Logic, Discrimination, Detail Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **I-B OXY/ACETYL WELD MILD STEEL**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

Oxy/ Acet Welding Equipment
Materials:
- M.S. Material
- M.S. Filler Rod
- S.T. as required

PERFORMANCE KNOWLEDGE

Determine type weld
Select filler rod size
Select tip size
Determine weld position
Weld in accordance to proper procedure

SAFETY – HAZARD

Refer to Index under Safe Practice
- X—Safety Precautions for Hand Tools—[Items 1 thru 10]
- XIX—Oxy-Acetylene Welding—[Items 1 thru 35]

DECISIONS

Determine type weld
Select filler rod
Select tip size
Determine position
Appraise condition of finished weld by visual inspection

CUES

Specs, Job Requirement, Joint design
Thickness of metal, bead size
Thickness of metal, bead size
Ease of application
General appearance, uniformity, penetration, etc.

ERRORS

Will not meet job specifications
Poor weld quality
Poor weld quality
Poor weld quality
Poor weld quality

(TASK STATEMENT) 1-B OXY/ACETYL WELD MILD STEEL

SCIENCE

Simple machines used to gain mechanical advantage.
Effect of heating and cooling on expansion of materials.
Fluids under pressure.
Transfer of energy from one form to another.
Transfer of heat from one body to another.
Arrangement of molecules, atoms and ions and the effect on structure and strength of materials.

[Different types carbon steels, physical characteristics]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
[Fractions]
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations
Basic Arithmetic Skills and Concepts—Ratio and proportion
[Weldment should be in direct relationship to the cross-section of parent metal]
Basic Measurement Skills and Concepts
Instruments—[basic measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings floor plans/blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gestures, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Terminology, Logic, Usage
Listening	Follow oral instructions	Discriminate facts, Logic Concentration, Note taking
Viewing	Appraise finished product	Visual analysis, Logic, Descrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **I-C OXY/ACETYL WELD PIPE**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy/Acetylene Equipment Materials: Steel Pipe M. S. filler rod Aligning fixture S. T. as required	Determine joint design Select filler rod Select tip size Determine weld position Align work Perform welding in accordance to proper procedure	Refer to Index under Safe Practice: X—Safety Precautions for Hand Tools—[Items 1 thru 10] XIX—Oxy-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Determine joint design Select filler Select tip size Determine weld position Appraise finish work by visual inspection	Specifications, job requirements Metal thickness Amount heat required Ease of application Appearance, penetration, uniformity, etc.	Will not meet job specifications Poor weld quality Poor weld quality Poor weld quality Poor weld quality

(TASK STATEMENT) **I-C OXY/ACETYL WELD PIPE**

SCIENCE

Simple machines used to gain mechanical advantage.
Effect of heating and cooling on expansion of materials.
Transfer of heat from one body to another.
Arrangement of molecules, atoms and ions and the effect on structure and strength of materials.

[Types and Physical properties of Steel Pipe]

MATH – NUMBER SYSTEMS

Set of Real Number—Positive Rationals
[Fractions]
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic measurements]
Measurement: Geometric
Linear
Angle
Measurement: Non-geometric
Temperature
Reading and interpreting tables, charts, and graphs
Scale drawings floor plans/blueprints.
Basic Geometry Skills and Concepts
Knowledge of geometric relationships
Parallel
Perpendicular
Determination of area and circumference of circles.
Determination of area and perimeter of an ellipse.
Determination of facts involving lines tangent to circles.

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gestures, Usage
Reading	Interpret blueprint and written specifications Measure and layout pipe according to blueprint or sketch	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisition for materials needed	Sketch, Description, Terminology, Logic, Usage
Listening	Follow oral instructions if given	Discriminate Facts, Logic, Concentration, Note taking
Viewing	Interpret blueprint and written specifications	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching	Examine finished product	Size, Shape, Temperature

(TASK STATEMENT) **I-D OXY/ACETYL WELD CAST IRON**

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TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy-Acetylene Welding Equipment S. T. as needed Cast Iron Filler Rod Cast Iron Material Flux	Determine type joint preparation Determine filler rod size Determine tip size Determine necessity of preheat/ postheat Select flux Complete weld according to proper procedure	Refer to Index under Safe Practice X— Safety Precautions for Hand Tools—[Items 1 thru 10] XIX— OXY-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Determine joint preparation Determine filler rod size Determine tip size Determine necessity of prehent/ postheat Determine flux Complete weld according to correct procedure.	Job requirement, condition of metal Determine by parent metal thickness Determine by parent metal thickness Weight and design of casting. A procedure necessity. Visual and specification.	Porosity, poor quality weld Poor quality, hard spots in weld Poor fusion, porosity, lack of penetration. Uneven expansion and contraction, possible cracking condition. Poor fusion, porosity, hard spots in weld.

TASK STATEMENT/ 1-D OXY/ACETYL WELD CAST IRON

SCIENCE

Simple machines used to gain mechanical advantage.
Effect of heating and cooling on expansion of materials.
Fluids under pressure..
Transfer of heat from one body to another
Arrangement of molecules, atoms and ions and the effect on structure and strength of materials.
Resistance of materials to change in shape.

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
- Addition algorithm
- Subtraction algorithm
- Multiplication algorithm
- Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.

Basic Measurement Skills and Concepts
- Instruments—[Basic Measurement]
- Measurement: Geometric
  - Linear
- Reading and interpreting tables, charts, and graphs
  - Scale drawings/ floor plans/ blueprints

Basic Arithmetic Skills and Concepts
- Ratio and proprotion
  - [Amount of preheat needed in relation to the weight and design of casting]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Read preheat and postheat temperatures as noted in written or oral instructions Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Examine finished weld	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) I-E BRAZE MILD STEEL 20

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy/Acetylene Equipment M. S. Material Bronze Filler Rod Proper Flux S. T. as required	Analyze job requirements Select filler rod size Select tip size Clean and prepare joint Determine weld position Apply proper flux and complete brazing operation in accordance to proper procedure	Refer to Index under Safe Practice X— Safety Precautions for Hand Tools—[Items 1 thru 10] XIX— OXY-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Analyze job requirement Select rod size Select tip size Determine position Appraise finished joint by visual inspection	Job requirements Metal thickness/joint design Metal thickness/joint design Ease of application General appearance, uniformity of bead	Will not meet job requirement Porosity, Poor bond Porosity, poor bond Porosity, poor bond Porosity, poor bond—appearance

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(TASK STATEMENT) **I-E BRAZE MILD STEEL**

SCIENCE

Simple machines used to gain mechanical advantage.
Effect of heating and cooling on expansion of materials.
Transfer of energy from one form to another.
[gases and fluxes]
Arrangement of molecules, atoms and ions and the effect on structure and strength of materials.
Metallurgical reasons for bond

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings, floor plans, blueprints
Basic Arithmetic Skills and Concepts
Ratio and proportion
[bond proportionate to parent metal]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisition for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instrictions—if given	Discriminate facts, Logic, Concentration, Note taking
Viewing	Examine work piece and finished product	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **I-F BRAZE CAST IRON**

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TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy-Acet. Equipment S. T. as required Cast iron material Bronze filler rod Flux	Determine preparation needed Select filler rod size Select tip size Determine position Determine preheat/postheat Apply proper flux-complete brazing operation following proper procedures.	Refer to Index under Safe Practice X— Safety Precautions for Hand Tools—[Items 1 thru 10] XIX— OXY-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Determine preparation needed Select fill rod size Select tip size Determine position Determine preheat/postheat Appraise finished work	Job requirement, joint design, condition of metal Job requirement, metal thickness, bead size Metal thickness Job requirement Job requirement Appearance, uniformity	Porosity, poor adhesion Porosity, poor adhesion Poor adhesion, appearance Poor appearnce Uneven expansion and contraction

(TASK STATEMENT) **I-F BRAZE CAST IRON**

SCIENCE

Simple machines used to gain mechanical advantage—[use of S.T.]
Effect of heating and cooling on expansion of materials—[cracks]
Fluids under pressure—[gas]
Transfer of heat from one body to another—[metals]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[weld and material]
Resistance of materials to change in shape—[cast iron cannot be bent or shaped at any temperature]

Metallurgical reasons for bond.

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Read preheat and postheat temperatures as noted in written or oral instructions Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise finished work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **I-G SILVER BRAZE STAINLESS STEEL**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy/ Acetylene Welding Equipment Material: Stainless Steel Silver Alloy filler wire Silver brazing flux S. T. as required	Determine joint design Select type and size of filler wire Select tip size Clean and prepare joint Determine position Apply proper flux complete work in accordance to proper procedure	Refer to Index under Safe Practice X – Safety Precautions for Hand Tools—[Items 1 thru 10] XIX— OXY-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Determine joint design Select type/size filler Select tip size Determine position Appraise finished work by visual inspection	Job requirements Physical, chemical properties Amount of heat requirement Ease of application General appearance, porosity, uniformity	Will not meet job specifications Will not meet job specifications Poor bonding Poor bonding Excessive heat breaks down physical properties of base metal

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(TASK STATEMENT) **I-G SILVER BRAZE STAINLESS STEEL**

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials—[distortion]
Transfer of energy from one form to another—[chemical reaction of fluxes]
Transfer of heat from one body to another—[capillary action]
Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[strength of bond]
[Physical and chemical properties of Silver Alloys and brazing fluxes]
[Types of stainless steel alloys]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
- Addition algorithm
- Subtraction algorithm
- Multiplication algorithm
- Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.

Basic Measurement Skills and Concepts
- Instruments—[Basic Measurement]
- Measurement: Geometric
  - Linear
- Reading and interpreting tables, charts, and graphs
  - Scale drawings/floor plans/blueprints

Basic Arithmetic Skills and Concepts
- [Bond Proportionate parent metal]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Perform operation, appraise finished work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **I-H SILVER BRAZE COPPER ALLOYS**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy-Acet. Equipment S. T. as required Copper alloy material Silver alloy filler wire Silver brazing flux	Determine joint design Determine preparation needed Select tip size Determine position Complete brazing operation following proper procedure	Refer to Index under Safe Practice X— Safety Precautions for Hand Tools—[Items 1 thru 10] XIX— OXY-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Determine joint design Determine preparation needed Select tip size Select filler wire size Determine position Appraise finished work	Job requirement Job requirement Thickness of base metal Thickness of base metal Ease of application Appearance, specification	Weakened weldment Porosity, poor adhesion Porosity, poor adhesion Material waste Poor quality and appearance

(TASK STATEMENT) I-H SILVER BRAZE COPPER ALLOYS

SCIENCE

Simple machines used to gain mechanical advantage—[use of Standard tools]
Effect of heating and cooling on expansion of materials—[size, shape]
Fluids under pressure—[gas]
Transfer of heat from one body to another—[rapid transmission]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[weld and material]

[Different silver brazing materials available]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed.	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise job	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) 1-I CUT USING OXY/ACETYLENE

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy/Acetylene Equipment Cutting Torch Assembly M. S. Material S. T. as required	Determine job requirements Layout material using center punch or scribe Select tip size Select proper gas pressures Preheat to start cut Open oxygen torch cutting valve and proceed to complete cut following layout	Refer to Index under Safe Practice X— Safety Precautions for Hand Tools—[Items 1 thru 10] XIX— OXY-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Job requirements Select tip size Select gas pressures Evaluate finished cut visually	Job requirements Thickness of metal to be cut Thickness of metal to be cut Cut should have uniform kerf, square edge.	Improper cut Improper cut Improper cut Excessive slag, rough edge, kerf too wide

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(TASK STATEMENT) I-I CUT USING OXY/ACETYLENE

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials—[distortion]
Fluids under pressure—[awareness of gases under pressure]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
- Addition algorithm
- Subtraction algorithm
- Multiplication algorithm
- Division algorithm
- Order of Operations, i.e., Use of parentheses in simplifying arithmetic expressions.

Basic Measurements Skills and Concepts
- Instruments—[Basic Measurement]
- Measurement: Geometric
  - Angle
- Measurement: Non-geometric
  - Temperature
- Reading and interpreting tables, charts, and graphs
  - Maps

Basic Geometry Skills and Concepts
- Knowledge of geometric relationships
  - Parallel
  - Perpendicular
- Determination of area and circumference of circles.
- Determination of area and perimeter of an ellipse.
- Determination of facts involving lines tangent to circles.

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisition for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Lay-out job according to blueprint, sketch, or instruction	Discriminate facts, Logic, Concentration, Note taking
Viewing	Set pressures according to manufacturers chart.	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **I-J FORM AND BEND**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy/Acetylene Equipment Material to be formed or shaped Jigs and/or Fixtures required S. T. as required	Determine job requirements Set-up Jig and/or fixture required Select heating torch and tip size Heat material until plastic enough to be formed to desired shape Complete operation to job requirements	Refer to Index under Safe Practice X— Safety Precautions for Hand Tools—[Items 1 thru 10] XIX— OXY-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Determine job requirements Set-up Jig and/or fixture Evaluate finished product by visual inspection	Job requirements Ease of performance Job requirements	Will not meet job specifications Will not meet job specifications Undesired physical properties

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(TASK STATEMENT) **I-J FORM AND BEND**

SCIENCE

Simple machines used to gain mechanical advantage—[S. T. as needed]
Effect of heating and cooling on expansion of materials—[change in dimension]
Effect of heating and cooling on state of matter—[material is made plastic]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[change physical properties]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Layout job according to blueprint, sketch, or oral instruction Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisition for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Perform operation, appraisal finished work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) HARDFACE

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy/Acet. equipment S. T. as required Grinder Steel or Steel Alloy material Hardfacing filler rod	Determine joint design Determine preparation needed Select tip size Select filler rod size and type Determine position Complete hardfacing operation—following proper procedure	Refer to Index under Safe Practice X— Safety Precautions for Hand Tools—[Items 1 thru 10] XIX— OXY-Acetylene Welding—[Items 1 thru 35]

DECISIONS	CUES	ERRORS
Determine joint design Determine preparation needed Select tip size Select filler rod size and type Determine position Appraise finished work	Job requirements Condition of metal, job requirement Thickness of base metal Results desired Ease of application Appearance and specifications	Material waste Poor adhesion, porosity Poor adhesion. Dilution of bead Wrong physical properties Poor appearance—too soft

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(TASK STATEMENT) I-K HARDFACE

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials—[cracks]
Fluids under pressure—[instability of gases]
Transfer of heat from one body to another—[effect of adjacent areas]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials
Resistance of materials to change in shape—[rigid and hard material]

[the metallurgy of hardfacing materials]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints

Basic Arithmetic Skills and Concepts—Ratio and proportion
[ratio of hardness of application to hardness of parent metal]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisition for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **I-L SOFT SOLDER**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Oxy/Acetylene Equipment Material to be Soft Soldered fixtures, chill block etc. as required Solder material as required Proper flux S. T. as required	Determine job requirements Determine procedure Select proper solder material Select proper flux Select tip size Position work to protect components from heat Complete operation following proper procedure	Refer to Index under Safe Practice X Safety Precautions for Hand Tools [Items 1 thru 10] XIX OXY-Acetylene Welding [Items 1 thru 35]

DECISIONS	CUES	ERRORS
Determine job requirement Determine procedure Select soldering material Select flux Evaluate finished operation by visual inspection	Job requirements Ease of application Type of metal being soldered Type of metal being soldered Amount of heat required General appearance, complete bond, neat and clean	Will not meet job requirements Poor bond

(TASK STATEMENT) I-L SOFT SOLDER

SCIENCE

Simple machines used to gain mechanical advantage—[use of Standard tools]
Effect of heating and cooling on expansion of materials—[finished product]
Transfer of energy from one form to another—[chemical reaction fluxes]
Transfer of heat from one body to another—[effect adjacent material]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[finished bond]
[Physical & chemical properties of soldering alloys and fluxes]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints

Basic Arithmetic Skills and Concepts—Ratio and proportion
Basic Geometry Skills and Concepts—Congruence

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisition for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

DUTY II. ELECTRIC ARC WELDING

A. Set up equipment for electric arc welding
B. Arc weld mild steel
C. Arc weld pipe
D. Arc weld stainless steel
E. Arc weld cast iron
F. Hardface
G. Cut metals

(TASK STATEMENT) **II-A SET UP AND ADJUST EQUIPMENT FOR ELECTRIC ARC WELDING**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC-DC Arc Welding equipment Cables and fittings S. T. as required	Determine operation requirements Connect correct power lead connection Connect correct electrode and ground cable connections Inspect current and polarity controls Inspect performance of welding machine	Refer to Index under Safe Practice: XVIII— Electric Arc Welding—[Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine amount of set-up necessary Determine correct power source and leads Determine correct electrode and ground cable connections Determine correct current and polarity settings Evaluate completed set-up	Operation requirement Operation requirement Operation requirement Electrode to be used Results	Incomplete set-up Machine will not function properly Poor performance Poor performance

(TASK STATEMENT) II-A SET UP AND ADJUST EQUIPMENT FOR ELECTRIC ARC WELDING

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Transfer of energy from one form to another—[electrical energy to heat]
Resistance of materials to flow of electrical current—[correct cable size]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
- Addition algorithm
- Subtraction algorithm
- Multiplication algorithm
- Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.

Basic Measurement Skills and Concepts
- Instruments—[Basic Measurement]
- Measurement: Geometric
  - Linear
- Reading and interpreting tables, charts, and graphs
  - Scale drawings/floor plans/blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Read and follow written instructions for set-up	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **II-B ARC WELD MILD STEEL**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC DC Arc Welding equipment M. S. Material Welding Electrodes S. T. as required	Determine joint design Select electrode type, size Determine weld position Select polarity Adjust current Strike Arc and complete weld in accordance to proper procedure	Refer to Index under Safe Practice: XVIII Electric Arc Welding [Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine joint design Select electrode size Determine weld position Select polarity Adjust amperage Evaluate finished weld by visual inspection	Job requirements Physical & chemistry, current requirements Ease of application Electrode requirement For penetration Good appearance, penetration informity	Will not meet job specifications Poor weld quality Difficult to perform Poor weld quality Poor weld quality Impurities, poor penetration, etc.

(TASK STATEMENT) II-B ARC WELD MILD STEEL

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials—[control distortion]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[weld]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
- Addition algorithm
- Subtraction algorithm
- Multiplication algorithm
- Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.

Basic Measurement Skills and Concepts
- Instruments—[Basic Measurement]
- Measurement: Geometric
  - Linear
- Reading and interpreting tables, charts, and graphs
  - Scale drawings/ floor plans/ blueprints

Basic Arithmetic Skills and Concepts—Ratio and proportion
[weld proportionate to parent metal]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications. Seek information.	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

AC DC Arc Welding equipment

S. T. as required
Alignment fixture
Steel Pipe
Electrodes

PERFORMANCE KNOWLEDGE

Determine joint design
Determine alignment procedure
Determine electrode size and type
Determine position
Determine polarity setting
Adjust current
Complete weld according to proper procedure

SAFETY – HAZARD

Refer to Index under Safe Practice:
XVIII Electric Arc Welding [Items 1 thru 28]

DECISIONS

Determine joint design
Determine alignment procedure
Determine electrode size and type
Determine position
Determine polarity setting
Adjust current
Appraise finished work

CUES

Job requirements, specifications
Job requirements, specifications
Job requirements, specifications
Ease of application
According to electrode type
Job requirement
Visual appearance, specifications

ERRORS

Lack of fusion and penetration
Misalignment of weldment
Poor quality of weld
Poor quality of weld, appearance
Poor quality of weld, appearance
Poor quality of weld, appearance

(TASK STATEMENT) II-C ARC WELD STEEL PIPE

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials—[change in material size]
Magnetic fields of force—[electrican characteristics]
Transfer of energy from one form to another—[Electrical energy to heat]
Transfer of heat from one body to another—[adjacent areas]
Resistance of materials to flow of electrical current—[cable size, electrode size]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
- Addition algorithm
- Subtraction algorithm
- Multiplication algorithm
- Division algorithm
- Order of Operations, i.e., Use of parentheses in simplifying arithmetic expressions.

Basic Measurements Skills and Concepts
- Instruments—[Basic Measurement]
- Measurement: Geometric
  - Angle
- Measurement: Non-geometric
  - Temperature
- Reading and interpreting tables, charts, and graphs

Basic Geometry Skills and Concepts
- Knowledge of geometric relationships
  - Parallel
  - Perpendicular
- Determination of area and circumference of circles.
- Determination of area and perimeter of an ellipse.
- Determination of facts involving lines tangent to circles.

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications Measure and lay-out pipe according to blueprint	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

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(TASK STATEMENT) **II-D ARC WELD STAINLESS STEEL**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC/DC Arc Welding equipment Stainless Steel material Stainless Steel electrodes S. T. as required	Determine joint design Select electrode type/size Determine welding position Select polarity Adjust current Set up work, proceed with weld; Technique used consistant with proper procedure	Refer to Index under Safe Practice. XVIII — Electric Arc Welding — [Items 1 thru 18]

DECISIONS	CUES	ERRORS
Determine joint design Select electrode type/size Determine weld position Select polarity Adjust current Set up work Appraise finished weld by visual inspection	Job requirement Physical & chemical property Ease of application Electrode requirement For proper penetration etc. Ease of operation Appearance, uniformity penetration	Does not meet requirement Does not meet requirement Job difficult to perform Poor weld quality Poor weld quality Job difficult to perform Impurities in weld, poor penetration, etc.

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(TASK STATEMENT) II-D ARC WELD STAINLESS STEEL

SCIENCE

Simple machines used to gain mechanical advantage—[standard tools]
Effect of heating and cooling on expansion of materials—[control distortion]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials
[physical and chemical characteristics of electrodes,
electrode coatings and their function]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/ floor plans/ blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed.	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Perform operation—appraise finished work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **II-E ARC WELD CAST IRON**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

AC DC Arc Welding equipment

S. T. as required
Grinder
Cast Iron material
Electrodes

PERFORMANCE KNOWLEDGE

Determine joint design
Determine preparation needed
Select electrode—size and type
Determine position
Determine polarity setting
Adjust current
Determine preheat/postheat needed
Complete weld, using proper procedure

SAFETY – HAZARD

Refer to Index under Safe Practice:
XVIII— Electric Arc Welding – [Items 1 thru 28]

DECISIONS

Determine joint design
Determine preparation needed
Select electrode—size and type
Determine position
Determine polarity setting
Adjust current
Determine preheat/postheat needed
Appraise finished work

CUES

Job requirement
Condition of metal-dirt, rust, etc.
Job requirement
Job requirement
Electrode requirement
Job requirement
Job requirement
Visual appearance and specifications

ERRORS

Material waste
Porosity—poor quality
Wrong physical properties
Poor bead shape
Poor quality of weld metal
Poor quality of weld metal
Possible cracking

(TASK STATEMENT) II-E ARC WELD CAST IRON

SCIENCE

Simple machines used to gain mechanical advantage—[standard tools]
Effect of heating and cooling on expansion of materials—[cracks]
Magnetic fields of force—[behavior of electric arc effected]
Transfer of energy from one form to another—[electric energy to heat]
Transfer of heat from ony body to another—[adjacent areas]
Resistance of materials to flow of electrical current—[cable size, electrode size]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[weld]
Resistance of materials to change in shape—[cast iron cannot be bent or shaped]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints
Basic Arithmetic Skills and Concepts—Ratio and proportion
[ratio of expansion and contraction to heating and cooling.]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Read preheat and postheat temperatures as noted in written or oral instructions Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **II-F HARDFACE**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC/DC Arc Welding equipment S. T. as required Grinder Steel or steel alloy material Hardfacing electrodes	Determine joint design Determine preparation needed Select electrode—size and type Determine position Determine polarity setting Adjust current Complete hardfacing operation according to procedure	Refer to Index under Safe Practice: XVIII— Electric Arc Welding—[Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine joint design Determine preparations needed Select electrode—size and type Determine position Determine polarity setting Adjust current Appraise finished work	Job requirement Job requirement Electrode used according to specifications Ease of application Determined by electrode type Job requirement Visual appearance and specification	Material waste Poor quality—poor adhesion Material waste—poor quality Poor shape of bead Poor quality Poor adhesion effects physical porperties Poor appearance—too soft

(TASK STATEMENT) **II-F HARDFACE**

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials—[cracks]
Transfer of heat from one body to another—[adjacent areas]
Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[weld]
Resistance of materials to change in shape—[rigid and hard]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
- Addition algorithm
- Subtraction algorithm
- Multiplication algorithm
- Division algorithm
- Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.

Basic Measurement Skills and Concepts
- Instruments—[Basic Measurement]
- Measurement: Geometric
  - Linear
- Reading and interpreting tables, charts, and graphs
  - Scale drawings/ floor plans/ blueprints

Basic Arithmetic Skills and Concepts—Ratio and proprotion
[comparison of cost of hardfacing to cost of new part]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **II-G CUT METALS**

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TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC/DC Arc Welding equipment Metal to be cut Cutting Electrodes Standard tools as required	Determine job requirements Select electrode type/size Layout metal using proper marking tool Adjust current Strike arc, complete cutting operation according to proper procedure	Refer to Index under Safe Practice: XVIII – Electric Arc Welding [Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine job requirements Select electrode type/size Adjust current Evaluate finished cut by visual inspection	Job requirements Type and thickness metal to be cut Type and thickness metal to be cut Uniformity, proper dimension, neat, etc.	Will not meet job requirements Poor, irratic, incomplete cut Poor, irratic, incomplete cut Poor, irratic, incomplete cut

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(TASK STATEMENT) II-G CUT METALS

SCIENCE

Simple machines used to gain mechanical advantage—[use standard tools]
Effect of heating and cooling on expansion of materials—[Distortion]
Transfer to energy from one form to another—[electrical energy converted to heat]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[heat effected zone]

[Physical and chemical characteristics of electrodes,
electrode coatings and their function]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications Lay-out job according to blueprint, sketch, or written instructions	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

DUTY III. TUNGSTEN INERT-GAS ARC WELDING

A. Set up Tungsten Inert-Gas welding equipment
B. TIG weld mild steel
C. TIG weld pipe
D. TIG weld stainless steel
E. TIG weld aluminum
F. TIG weld cast iron
G. Hardface

(TASK STATEMENT) **III-A SET UP TUNGSTEN-INERT-GAS WELDING EQUIPMENT**

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TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC/DC Arc Welding Equipment with Hi-frequency unit. Cables and fittings TIG Torch assembly Tungsten electrodes Inert gas supply S. T. as required	Determine operation requirement Determine power lead connection Determine electrode and ground cable connection Determine water supply connections Determine flow meter connections Determine torch assembly connections Inspect all controls Evaluate completed set-up.	Refer to Index under Safe Practice: XVIII— Electric Arc Welding– [Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine amount of set-up necessary Correct placement of power lead Correct electrode and ground cable connections Correct water supply connection Correct flow meter connections Correct torch assembly connection Correct setting and function of controls Evaluate completed set-up	Job requirements Connect according to directions Connect according to directions Ample supply Set-up requirement Set-up requirement Set-up requirement All phases working	Wrong rotation Wrong polarity possible Overheating Leaks weld contamination Leaks weld contamination Leaks weld contamination

(TASK STATEMENT) III-A SET UP TUNGSTEN-INERT-GAS WELDING EQUIPMENT

SCIENCE

Indestructibility of energy and matter—[non-consumable electrode]
Simple machines used to gain mechanical advantage—[use of Standard Tools]
Effect of heating and cooling on state of matter—[changes possible physical metallurgy]
Transfer of heat from one body to another—[Heat treating]
Resistance of materials to flow of electrical current—[cable size, Electrode size]
Relationship of force to distortion in an elastic body—[Forging and Shaping]
Arrangement of molecules, atoms and ions and the effect on structure and strength of materials—[Welds and Metals]
Fluids under pressure—[inert gases and their function]
Physical characteristics of inert gases and their function

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Basic Measurement Skills and Concepts—Instruments
[read gauge pounds per square inch, cubic feet per hour]

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COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Read and follow written instructions for set-up	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

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(TASK STATEMENT) **III-B TIG WELD MILD STEEL**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC/DC Arc Welding Equipment—Hi-frequency capability Flow Meter Regulator TIG Welding Torch Tungsten Electrodes Inert Gas Supply M. S. Material M. S. Filler Rod S. T. as required	Determine joint design Select electrode size Determine weld position Select polarity Adjust current Adjust inert-gas flow Set and adjust hi-frequency Set up work, complete weld according to proper procedure	Refer to Index under Safe Practice: XVIII— Electric Arc Welding—[Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine joint design Select electrode size Determine position Adjust current Adjust gas flow Set and adjust hi-frequency Appraise finished work by visual inspection	Job requirement or specs Current requirements Ease of application Proper penetration Proper shielding Spark intensity, mode, etc Appearance, Penetration, Uniformity, etc.	Does not meet requirement Improper Arc characteristics Poor weld quality Poor weld quality Poor weld quality Electrode contamination Porosity, penetration cracks, etc.

(TASK STATEMENT) III-B TIG WELD MILD STEEL

SCIENCE

Simple machines used to gain mechanical advantage.—[use of standard tools]
Effect of heating and cooling on expansion of materials—[Control distrotion]
Transfer of heat from one body to another—[water cooled torch]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[strength of weld]
[Physical characteristics of inert gases and their function]
[Different types of Tungsten Electrodes and their use Hi-frequency and its function]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints

Basic Arithmetic Skills and Concepts—Ratio and proportion
[Weldment proportional to parent metal]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint or written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **III-C TIG WELD PIPE**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC/DC Arc Welding equipment with High-frequency unit. TIG Torch Assembly Tungsten Electrode Inert gas supply Aligning fixture Pipe Filler rod St. T. as required	Determine joint design Determine alignment procedure Determine electrode size and type Determine filler rod size and type Determine position Determine current setting Determine polarity setting Determine gas flow Complete weld according to proper procedure	Refer to Index under Safe Practice: XVIII — Electric Arc Welding – [Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine joint design Determine alignment procedure Select electrode size and type Select filler rod size and type Determine position Select current setting Select polarity setting Set gas flow Appraise finished work	Job requirement or specification Job requirement or specification According to parent metal According to parent metal More efficient-ease of application Job requirement-specification Job requirement-specification Job requirement-specification Visual appearance and specifications	Lack of fusion and penetration Misalignment of weldment Poor quality of weld Poor quality of weld Poor quality of weld Poor quality of weld Poor quality of weld Weld contamination

(TASK STATEMENT) **III-C TIG WELD PIPE**

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion ofmaterials—[change in material size]
Transfer of energy form one form to another—[electrical energy to heat]
Transfer of heat from one body to another—[effect on adjacent areas]
Resistance of materials to flow of electrical current—[cable size, electrode size]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[strength of weld]
[Physical characteristics of inert gases and their function]
[Tungsten electrodes—types High-frequency and its functions]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of Operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurements Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Angle
Measurement: Non-geometric
Temperature
Reading and interpreting tables, charts, and graphs
Basic Geometry Skills and Concepts
Knowledge of geometric relationships
Parallel
Perpendicular
Determination of area and circumference of circles.
Determination of area and perimeter of an ellipse.
Determination of facts involving lines tangent to circles.

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications Measure and lay-out pipe according to blueprint or sketch	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **III-D TIG WELD STAINLESS STEEL**

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TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC/DC Arc Welding Equipment Hi-frequency capability Flow Meter Regulator TIG Welding Torch Tungsten Electrodes Inert Gas Supply Stainless Steel Material Stainless Steel Filler Rod S. T. as required	Determine joint design Select electrode size Determine welding position Select polarity Adjust current Adjust inert gas flow Set and adjust hi-frequency Set up work, complete weld according to proper procedure	Refer to Index under Safe Practice: XVIII Electric Arc Welding—[Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine joint design Select electrode size Determine weld position Adjust current Adjust gas flow Set and adjust hi-frequency Appraise finished work by visual inspection	Job requirements or specs Current required Ease of application Proper penetration Proper shielding Spark intensity, mode, etc. Appearance, penetration, etc.	Does not meet requirements Improper arc characteristics Poor weld quality Poor weld quality Poor weld quality Electrode contamination Porosity, poor penetration, cracks, etc.

(TASK STATEMENT) **III-D TIG WELD STAINLESS STEEL**

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials—[controling distortion]
Transfer of heat from one body to another—[water cooled torch]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials
[Physical characteristic of inert gases and their function]
[Different types Tungsten Electrodes and their use Hi-frequency and its function]
Weldable and non-weldable stainless steels

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints
Basic Arithmetic Skills and Concepts—Ratio and proportion
[Weldment proportional to parent metal]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **III-E TIG WELD ALUMINUM**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC/DC Arc Welding Equipment Hi-frequency capability Flow-meter Regulator TIG Welding Torch Tungsten Electrodes Inert Gas Supply Aluminum Material Aluminum filler Rod Standard tools as required	Determine joint design Select electrode size Select filler type/size Determine welding position Adjust current Adjust inert-gas flow Set and adjust hi-frequency Set up work complete weld according to proper procedure Determine preheat needed	Refer to Index under Safe Practice. XVIII – Electric Arc Welding [Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine joint design Select electrode size Select filler type/size Determine weld position Preheat to required temperature Adjust current Adjust inert-gas flow Set/Adjust hi-frequency Appraise finished weld by visual inspection	Job requirement or specs Current required Job Requirements Ease of application Job requirement Proper penetration [illegible]per shielding [illegible], Spark intensity Appearance, penetration, uniformity, etc.	Will not meet job specifications Improper arc characteristics Poor weld quality Poor weld quality Poor fusion—appearance Poor weld quality Poor weld quality Electrode contamination Porosity, poor penetration, cracks, etc.

(TASK STATEMENT) III-E TIG WELD ALUMINUM

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools
Effect of heating and cooling on expansion of materials—[controling distortion]
Transfer of heat from one body to another—[water cooled torch]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials
[Physical characteristics of inert gases and their function]
[Different types Tungsten Electrodes and their use.]
[Hi-frequency and its function]
Weldable and non-weldable aluminum alloys

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints
Basic Arithmetic Skills and Concepts—Ratio and proportion
[Weld proportionate to parent metal]

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COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisition for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **III-F TIG WELD CAST IRON**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
AC/DC Arc Welding equipment with High-frequency unit TIG Torch Assembly Tungsten Electrode Inert gas supply Filler rod Grinder Cast iron material S. T. as requireed	Determine joint design Determine preparation needed Determine electrode-size and type Determine filler rod size and type Determine necessity of preheat or postheat Determine position Determine polarity Determine current setting Determine gas flow Complete weld according to proper procedure	Refer to Index under Safe Practice: XVIII – Electric Arc Welding – [Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine joint design Determine preparation needed Select electrode size and type Select filler rod size and type Select preheat and/or postheat Select position Set polarity Make current setting Set gas flow Appraise finished work	Job requirement Condition of metal, dirty, rusty etc. Procedure requirement Procedure requirement Weight and shape of casting Better and more efficient results Job requirement Job requirement Job requirement Visual and specification	Lack of fusion and penetration Porosity, poor quality of weld Drop in quality of weld Porosity, poor quality of weld Possible cracks in casting Poor shape of weld bead May not be feasible Porosity, lack of fusions bad bead shape Contamination of weld and electrode Poor quality of finished job

(TASK STATEMENT) III-F TIG WELD CAST IRON

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials
[fast cooling may cause uneven contraction, cracks]
Transfer of energy from one form to another—[electric energy to heat]
Transfer of heat from one body to another—[effect of adjacent areas]
Resistance of materials to flow of electrical current—[cable size, electrode size]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[weld]
Resistance of materials to change in shape—[cast iron cannot be bent or shaped]
[Characteristics of inert gases and function]
[Types of tungsten electrodes]
[Function of high-frequency]
[Filler rods used-cast iron and nickel]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints
Basic Measurement Skills and Concepts—Measurement: Non-geometric
Temperature [Checking and Controlling]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Read preheat and postheat temperatures as noted in written or oral instructions	Comprehension, Detail, Proposals, Description, Terminology, Instruction
	Interpret blueprint and written specifications	
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **III-G HARDFACE**

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TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

AC/DC Arc Welding equipment with High-frequency unit.
TIG Torch assembly
Tungsten electrode
Inert gas supply
Steel or Steel alloy
Filler rod
Grinder

PERFORMANCE KNOWLEDGE

Determine joint design
Determine preparation needed
Determine electrode size and type
Determine filler rod size and type
Determine position
Determine current setting
Determine polarity setting
Determine gas flow
Complete weld according to proper procedure

SAFETY – HAZARD

Refer to Index under Safe Practice:
XVIII— Electric Arc Welding—[Items 1 thru 28]

DECISIONS

Determine joint design
Determine preparation needed
Select electrode size and type
Select filler rod size and type
Determine position
Select current setting
Select polarity
Set gas flow
Appraise finished job

CUES

Job requirement
Job requirements and condition of metal
Metal thickness
Job requirement
Ease of application
Job requirement
Job requirement
Job requirement
Visual appearance and specification

ERRORS

Material waste
Poor quality, poor adhesion
Poor quality, appearance
Poor quality undersired physical properties
Poor shape of bead
Poor quality, dilution of bead
Poor quality, or not feasible
Weld contaminations and oxidation

(TASK STATEMENT) III-G HARDFACE

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials—[material size, distortion]
Transfer of energy from one form to another—[electrical energy to heat]
Transfer of heat from one body to another—[adjacent areas]
Resistance of materials to flow of electrical current—[cable size, electrode size]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[weld and material]
Resistance of materials to change in shape—[rigid and hard materials]
[The metallurgy of hardfacing materials]
[The characteristics of inert gases-function]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints

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COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

DUTY IV. METALLIC INERT-GAS ARC WELDING

A. Set up equipment for Metallic Inert-Gas welding
B. MIG weld carbon steels
C. MIG weld pipe
D. MIG weld aluminum

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(TASK STATEMENT) **IV-A SET UP EQUIPMENT FOR METALLIC INERT-GAS**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Constant Voltage, Direct Current Welding Machine Power Input supply Inert Gas supply Wire-feed assembly and controls Water supply Flow meter regulator Ground and Electrode cables MIG Torch Assembly Filler wire on reel Standard Tools as required	Connect machine to power supply Attach water supply to machine Attach cables to ground and torch Attach flow meter to inert-gas supply Attach filler wire reel to feed assembly Adjust wire feed and current control Adjust voltage Imspect for operation procedure	Refer to Index under Safe Practice: XVIII — Electric Arc Welding—[Items 1 thru 28]

DECISIONS	CUES	ERRORS
Connect machine to power supply Attach water supply Attach cables to ground and torch Attach flow meter Adjust wire feed current Adjust voltage Appraise operation by actual test use	Current requirements of machine Needed to keep torch cool Make positive and secure To control shielding gas Amount needed for operation For smooth Arc Proper wire feed, good Arc characteristic, good deposit	Damage to machine Damage torch through overheating Poor connections, Damage equipment Poor weld quality Improper weld deposit Improper weld deposit Improper weld deposit, poor Arc characteristics

(TASK STATEMENT) IV-A SET UP EQUIPMENT FOR METALLIC INERT-GAS

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Work input, work output, friction and efficiency in simple machines
[wire fed assembly operation]
Transfer of heat from one body to another—[water cooled torch]
[Physical characteristic of inert gases and their function]
[Different types filler wire]
[Short-arc and Spray Arc]
[methods of application]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings, floor plans, blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Read and follow written instructions for set-up	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **IV-B MIG WELD CARBON STEELS**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
MIG Welding Equipment Inert-Gas Supply Flow meter Regulator MIG Torch Assembly Filler Wire Supply Standard tools as required	Determine joint design Select wire size Determine weld position Adjust inert gas flow Adjust wire feed and current control Adjust Voltage Set-up work, complete weld according to proper procedure	Refer to Index under Safe Practice: XVIII— Electric Arc Welding—[Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine joint design Select wire size Determine welding position Adjust gas flow Wire feed and current control Adjust voltage Appraise finished weld by visual inspection	Job requirements, specifications Current requirements Ease of application Proper shielding Amount needed for operation Smooth Arc Appearance, uniformity bend, penetration	Will not meet job specifications Poor Arc characteristics Poor weld quality Poor weld quality Poor weld quality Poor Arc characteristics Porosity, penetration too great or too little

(TASK STATEMENT) **IV-B MIG WELD CARBON STEELS**

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Work input, work output, friction and efficiency in simple machines
[wire feed assembly operation]
Effect of heating and cooling on expansion of materials—[control distortion]
Transfer of heat from one body to another—[water cooled torch]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials
[Physical characteristics of inert gases and their functions]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings, floor plans, blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) **IV-C MIG WELD PIPE**

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON

MIG Welding equipment:
- Inert gas supply
- Filler wire
- Aligning fixture
- S. T. as required
- Pipe

PERFORMANCE KNOWLEDGE

Determine joint design
Determine alignment procedure
Select wire size and type
Determine position
Adjust voltage setting
Set wire feed speed
Select gas flow
Complete weld according to proper procedure and specifications

SAFETY – HAZARD

Refer to Index under Safe Practice:
XVIII – Electric Arc Welding – [Items 1 thru 28]

DECISIONS

Determine joint design
Determine alignment procedure
Select wire size and type
Determine position
Adjust voltage setting
Set wire feed speed
Set gas flow
Appraise finished work

CUES

Job requirement-specification
Job requirement and procedure
Job requirement-base metal
More efficient-ease of application
Job requirement
Current requirement, bead size
Job requirement, specification
Visual evaluation, specifications

ERRORS

Lack of fusion and penetration
Misalignment of weldment
Poor quality
Poor quality
Lack of fusion, poor quality
Lack of fusion, poor appearance
Appearance; contamination

(TASK STATEMENT) IV-C MIG WELD PIPE

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Effect of heating and cooling on expansion of materials
[change in material size]
Magnetic fields of force—[effects electric Arc characteristics]
Transfer of energy from one form to another—[electrical energy to heat]
Transfer of heat from one body to another—[effect on adjacent areas]
Resistance of materials to flow of electrical current—[cable size, wire size]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[weld]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of Operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurements Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Angle
Measurement: Non-geometric
Temperature
Reading and interpreting tables, charts, and graphs
Basic Geometry Skills and Concepts
Knowledge of geometric relationships
Parallel
Perpendicular
Determination of area and circumference of circles.
Determination of area and perimeter of an ellipse.
Determination of facts involving lines tangent to circles.

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisitions for material	Terminology, Logic, Gesture, Usage
Reading	Measure and lay-out pipe according to blueprint or sketch Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

(TASK STATEMENT) IV-D MIG WELD ALUMINUM

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
MIG Welding equipment Inert gas supply Filler wire S. T. as required Aluminum material Flow Meter Regulator	Determine joint design Determine preparations needed Determine weld position Adjust gas flow Adjust wire feed and current control Adjust voltage Select wire size and type Complete weld according to proper procedure Determine preheat needed	Refer to Index under Safe Practice: XVIII — Electric Arc Welding [Items 1 thru 28]

DECISIONS	CUES	ERRORS
Determine joint design Necessary cleaning Position necessary Set as flow Set wire feed and current Set voltage Select wire size and type Appraise finished work Preheat to specified temperature	Job requirements, Specification Condition of Metal Ease of application Job requirement Job requirement Job requirement Thickness and type of base metal Appraise weld visual and specifications Job requirement, specifications	Not same as specifications Porosity in weld Poor appearance Porosity, poor quality Poor fusion, appearance Poor Arc characteristics Wrong physical characteristics Poor fusion, appearance

(TASK STATEMENT) **IV-D MIG WELD ALUMINUM**

SCIENCE

Simple machines used to gain mechanical advantage—[use of standard tools]
Work input, work output, friction and efficiency in simple machines
[wire feed mechanism]
Effect of heating and cooling on expansion of materials
[change in material size, distortion]
Magnetic fields of force—[effects electric arc characteristics]
Transfer of energy from one form to another—[Electrical energy to heat]
Arrangement of molecules, atoms and ions and the effect on
structure and strength of materials—[strength of weld and material]
[Weldable and non-weldable aluminum alloys, tempers]

MATH – NUMBER SYSTEMS

Set of Real Numbers—Positive Rationals
Fundamental Operations (Calculation)
Addition algorithm
Subtraction algorithm
Multiplication algorithm
Division algorithm
Order of operations, i.e., Use of parentheses in simplifying arithmetic expressions.
Basic Measurement Skills and Concepts
Instruments—[Basic Measurement]
Measurement: Geometric
Linear
Reading and interpreting tables, charts, and graphs
Scale drawings/floor plans/blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking	Make oral requisition for materials	Terminology, Logic, Gesture, Usage
Reading	Interpret blueprint and written specifications	Comprehension, Detail, Proposals, Description, Terminology, Instruction
Writing	Make written requisitions for materials needed	Sketch, Description, Logic, Terminology, Usage
Listening	Follow oral instructions	Discriminate facts, Logic, Concentration, Note taking
Viewing	Appraise work	Visual analysis, Logic, Discrimination, Detail, Recognition of symbols, Codes, etc.
Touching		Size, Shape, Temperature

ABBREVIATIONS

Acetyl—Acetylene
M.S.—Mild steel
Oxy—Oxygen
S.T.—Standard tools:

- center punch
- clamps
- cold chisel
- combination square
- compass
- dividers
- files
- hacksaw
- hammer-chipping
- hammer-ballpeen
- marking crayon
- pliers-combination
- pliers-vise grips
- protracters
- screwdriver
- scriber
- steel rules
- tape measure

INDEX
EYE PROTECTION

Some type of eye protection should be worn for all operations where open flame and/or arc welding is being performed, both by the operator and those who may be required to be close by. The oxy-acetylene, flame and molten puddle, has a high temperature and concentration, emits a large eqantity of ultra-violet and infra-red rays which are injurious to the eyes and skin. Special lens in goggles and face shields of a green or amber shade filter out most of these harmful rays while allowing the green, orange and yellow rays to pass through. These lenses come in shades numbered from one to twelve. Two factors must be considered when determining the numbered lense shade to be used for best visibility of puddle detail with the least amount of eye strain and skin burn or injury. First, the intensity of the flame or arc; second, the size of the pool of molten metal. The following is a list of recommended lens shades to be used for different operations:

OPERATIONS	LENS SHADE
Soft soldering and light brazing	No. 1-3
For heavy silver-brazing, bronze welding and brazing; and wleding of light gauge metal with open flame (oxy-acet)	No. 4
For medium welding, heavy brazing with oxy-acet	No. 5
For heavy welding and burning with oxy-acet	No. 6
For very light Tig welding (up to 10 Amp) and for short periods of time (one to five min.)	No. 8
For medium Tig welding (10-100 Amp) and light arc welding (stick electrode)	No. 9
For heavy Tig welding and medium arc welding (up to 200 amps)	No. 10
For amp exceeding 200	No. 11-12

These are, of course, all recommended uses. A good rule to follow is to use as dark a lens as possible with maximum visibility and a minimum of discomfort for the operator.

INDEX
SAFE PRACTICES
IN WELDING

I. Introduction:
Safety is a major objective in every welding shop. It is the most important attitude a operator must learn in becoming a proficient tradesman. Therefore the goal of these safety policies is to provide a strong safety program for the benefit of all involved.

II. General Safety Precautions:
1. Walk—do not run in shop areas.
2. Remember horseplay has no place in the shop.
3. Work with tools, machines and equipment only after having received proper instruction.
4. Get help for lifting heavy or awkward objects
5. Wear approved eye protection at all times.
6. Report any and all injuries immediately.
7. Never throw objects in shop area, distraction and injury can result.
8. Be careful of long hair around moving parts of machinery.
9. Be considerate for safety of others.

III. Safety Precautions for Metal Saws.
1. When turning on power, stand to one side of saw frame, and adjust speed to suit work.
2. Mount work only when saw is stopped.
3. Support protruding end of work or material being cut so end will not fall and cause possible injury to anyone.
4. Be sure that the blade is in good condition before using.
5. If blade breaks in work, shut off power and do not attempt to disengage blade from work until the machine has come to a stop.

IV. Safety Precautions for Drill Press
1. Use drills that are properly sharpened and that run true.
2. Chuck wrenches must be removed from drill chucks before starting the machine.
3. Never attempt to hold work under the drill by hand. Always clamp work to table.
4. Change belt for speeds only when power is "Off."
5. Run drills at proper speed. Forcing or feeding too fast may result in broken or splintered drills and serious injuries.
6. Keep your head back and well away from any moving part of the drill press.

V. Safety Precautions on Grinders—Pedestal Type:
1. Stand to one side out of line of wheel when starting it up, especially if wheel is new.
2. The face of the wheel must be flat and free from grooves.
3. Make sure the tool rest is only one-eighth inch from the face of the wheel. Check this distance, too much clearance may cause the job to jam the wheel and break it.

4. Do not set tool rest while machine is in motion.
5. Work should be fed slowly and gradually. Using too much pressure or striking wheel suddenly, may cause it to break.
6. Hold job against wheel firmly so that it will not slip out of the hand and cause hands and fingers to come in contact with wheel.
7. Use clamp or other suitable holding devices for grinding short pieces.
8. Stop wheel if it chatters or vibrates excessively. This may be a danger signal that the wheel is not properly balanced or not attached securely to spindle.
9. Always use face shield or goggles even if grinder is provided with protective glass shields.

VI. Safety Precaution on Sheet Metal Brake

1. Keep fingers clear of the mouth of the machine when closing down on the metal.
2. Use care when inserting or removing sharp edged sheets.
3. Make sure counterweight bars do not strike others while working.
4. Get assistance when bending large thick material to avoid backstrain.
5. Keep fingers out of pinch area as the metal is bent, especially on maximum capacity bends.

VIII. Safety Precautions on Shears and Punch

1. Fingers must be kept out of the cutting or punching area.
2. Keep your attention on the job; avoid distractions while working.
3. Always use properly installed guards.
4. The shear and punch will be operated normally by one person only.

IX. Safety Precautions on Squaring Shear

1. Keep fingers clear of the blade and never under the hold down bar.
2. Never reach behind the shear to support metal. This places you in an awkward position, subject to a fall and puts fingers in a blind area.
3. To avoid crushing toes, keep feet clear of the pedal.
4. Use care in handling sheared razor sharp metal.
5. Never cut excessively small pieces on a shear; use hand snips.
6. The shear is a one man machine; use accordingly.
7. In leaning forward as blade is depressed, people tend to keep balance by grasping the top of the large outer-casting. After the blade has descended, it is possible to insert a finger inadvertently into the slide, as the blade returns, a very serious crush can result.

X. Safety Precautions for Hand Tools

Hand Tools, General:

1. Clamp work securely in vises, but do not hammer on vise handles.
2. Remove filings and chips from bencehes with a brush, not the hands.
2. Do not allow work to project from vise or bench and cause obstructions.
4. Use the correct size wrench for the job.
5. When using cutting tools, direct the cutting action away from you.
6. Mushroom heads on chisels, punches, etc., should be eliminated continuously.
7. Avoid carrying tools in pockets. Screwdrivers, etc. can injure you if you fall.

8. Inspect hand tools before using.
9. When using tin snips or other similar tools, avoid letting flesh come between the handles. Pinches and blisters generally result.
10. When using a chipping hammer, chip toward wall or shield to protect others from flying chips.

XI. *Screw Drivers*

1. Select screw drivers to fit screw head being used.
2. Keep screw driver handle smooth.
3. Do not use a hammer on a screwdriver handle.
4. Avoid holding work in the hand when using a screwdriver on it, as it may slip and cause stab wounds.
5. Never grind a screwdriver to a chisel edge.

XII. *Wrenches*

1. Discard wrenches that are spread.
2. Select open-end wrenches to fit the job.
3. When possible, avoid using an *adjustable* or *monkey wrench.*
4. If a wrench has been burred, grind off the rough spots to avoid cutting the hands.
5. It is generally safer to pull wrench toward yourself than to push it away from you.
6. Be sure that your knuckles will clear obstructions when the wrench turns.

XIII. *Hammers:*

1. Hammers that are chipped should be discarded.
2. Never use a hammer that has a loose or split handle.

XIV. *Chisels:*

1. In using a chisel and hammer, keep the chisel head free from burring by grinding it if necessary.
2. Where chips may fly, use a shield to protect others.
3. Hold the chisel and hammer firmly.
4. Do not use a chisel with a mushroomed head.

XV. *Files:*

1. Always use a file with a handle.
2. Never use a file as a pry bar.
3. Keep firm grip on file at all times.
4. Do not blow filings so that they can go into anyone's eyes.
5. Make sure the work to be filed is securely mounted.

XVI. *Pliers:*

1. When using pliers, keep hands clear of the pinch area. This may be at the rear of the bolt as well as ahead.
2. Place hands over short wire pieces, cotter pins or other small items being cut. Such items tend to fly and may cause eye injury.
3. Remove any burrs caused by pliers which can cause injury.

XVII. *Hacksaws:*

1. Use the correct blade for the job.

2. See that blade is securely fixed in the frame.
3. When the saw breaks through work, ease up on the pressure so that the hand will not strike the work or vise.

XVIII. *Electric Arc Welding*

1. Avoid looking at the arc or flash unless equipped with appropriate dark glasses.
2. Helmets and welding goggles must be free of cracks or holes permitting penetration of intense light.
3. Wear protective clothing to help protect the skin from intense rays.
4. Always wear gloves. Leather gauntlet type that can be thrown off are recommended.
5. Where necessary, wear leather aprons, arm coverings or other protection to protect from molten metal or hot sparks.
6. Where a helper is used, he must be protected the same as the welder.
7. Wear high type shoes rather than undercut shoes.
8. Always wear eye protection when chipping. Never chip if there is a possibility someone nearby without glasses will be struck by flying chips.
9. Keep sleeves and pants cuffs rolled down and collar buttoned up.
10. Never touch a piece of metal in the welding area if uncertain about the temperature.
11. Mark hot metal to read "HOT."
12. Do not handle excessively hot metal with gloves unless cool area beyond hot spot permits safe handling.
13. Exercise good judgement in selecting welding jobs. Automotive work is especially hazardous due to fuel tank, fuel line, hydraulic lines, flammable upholstery, etc.
14. Special metals require the use of respirators to protect welders from harmful fumes. Adequate ventilation is always desirable, especially when welding galvanized materials.
15. Toxic gas, phosgene, is formed when the ultra-violet rays of an electric arc come in contact with chlorinated degreasing solvents. Metal cleaned with carbon tetrachloride and trichlorethylene should not be welded until throughly dried.
16. Never strike an arc on compressed air cylinders.
17. Work in dry area.
18. Do not get wound up in your work! Keep cables free from your body so you can move freely, especially should your clothing ignite or some other such accident occur.
20. Ground work before turning on welder.
21. Do not change polarity or connections while a welder is being used.
22. Keep floor free of electrodes once you begin to weld. They could cause a slip or fall.
23. Place stubs in metal container.
24. Never tack weld without a helmet.
25. Keep clamps and other tools off the floor and put away. They can cause a fall.
26. Ground the work before turning on welder.
27. Keep clamps and other tools off the floor and put away. They can cause a fall.
28. Replace the cables by coiling them to eliminate tripping hazards.

XIX. *Oxy-Acetylene Welding*

1. Before attaching a regulator to a cylinder valve, "crack" the valve to blow out dust and dirt.

2. Do not use oil on the torch, blow pipe, valves, regulators, or any other portion of the equipment.
3. Check for leaks whenever you change tanks or suspect a leak.
4. Leaks around equipment should be checked with soapy water, never a flame.
5. Should you suspect a leak in any equipment, stop until repairs are made.
6. Avoid the use of pliers on apparatus. Use torch wrench and turn right for oxygen connections and left for gas or acetylene connections.
7. Keep cylinders in upright position.
8. Open cylinder valves gradually.
9. Open the oxygen valves wide to prevent leakage.
10. Open acetylene cylinder valve one-eighth to one-quarter turn.
11. Keep wrench on acetylene cylinder valve while in use so it can be shut off quickly if necessary.
12. Under no circumstances will acetylene pressure exceed 15 pounds. If used in excess of this amount, an explosion may result.
13. Make sure connections are tight when you change tips or other apparatus. Do not overtighten.
14. Do not use oxygen to blow dirt off your clothes.
15. Use correct type eye protection for all operations.
16. Keep your welding equipment in good, clean, dry condition.
17. Use ventilating system or means of ventilation provided.
18. Keep welding area neat, clean, and dry.
19. Make certain the fire extinguisher is in place and that you know how to use it.
20. Do not permit autos or equipment to run over the hoses. Protect them from sharp objects, kinks, etc.
21. Keep the hose out of the way so it does not become a tripping hazard.
22. Make sure you do not drag the hose over hot metal scrap when cutting.
23. Use flint spark lighters, never matches or cigarette lighters.
24. Purge oxygen and acetylene line before lighting torch.
25. Use special care when cutting so hot pieces do not fall or tumble onto feet. Do not stand with feet so close to the cutting that they are subject to intense heat, sparks, and molten metal.
26. Never lay down or hand up a lighted torch or blowpipe and leave welding station.
27. Hot metal should be marked "HOT" with chalk or soap stone.
28. Adjusting screws on regulators should always be released when not in use. Turn the screw out counter clockwise.
29. Never allow a cylinder to fall. They are under high pressure internally and can explode if ruptured by a sudden shock. Always secure cylinder to a stationary object.
30. Never use oxygen or acetylene directly from tanks without the use of regulators.
31. Cylinders should not come in contact with electric wires.
32. Never tamper with the fusible safety plugs.
33. Acetylene piping, hoses and fittings should be color coded "Red."
34. Never "crack" a cylinder in the vicinity of an open flame or fire source.
35. Keep protective cylinder valve covers secured on cylinders when not in use.